

Optimizing Inventory Management using Object-Centric Process Mining*

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Abstract. Efficient inventory management is crucial for a retail company’s success, directly impacting sales and costs. We introduce an Object-Centric Data Model (OCDM) to optimize inventory management-related processes, such as Order-to-Cash (O2C) and Purchase-to-Pay (P2P), by abstracting the complexity of these processes and unifying data from various information systems. Enriching the OCDM with inventory management-related metrics enables an event-driven assessment of root causes for inefficiencies, i.e. understock and overstock situations. We applied the OCDM to a pet retailer company, where we observed improvements in demand forecasting models and supplier contract adjustments. The results demonstrate significant potential for reducing understock and overstock.

Keywords: Inventory Management · Object-Centric Data Model · Objects Interaction Analysis.

1 Introduction

Inventory management ensures product availability meets customer demand while balancing costs, avoiding *understock* (loss of sales) and *overstock* (high capital commitment and storage costs) situations [5]. The efficient management of related processes, such as Order-to-Cash (O2C) and Purchase-to-Pay (P2P), directly impacts a company’s success. Existing solutions to optimize these processes, including **(1)** exact mathematical optimization models [5], **(2)** business management techniques [3], **(3)** ETL methodologies [2], and **(4)** traditional/object-centric process mining approaches [4] lack standardization and process-related root cause analysis for inefficiencies [1].

We address these challenges by introducing an Object-Centric Data Model (OCDM) that integrates various data sources to provide a holistic view of inventory management and related processes. The OCDM standardizes data collection and is enriched with relevant metrics, enabling a comprehensive process behavior analysis.

We applied the OCDM in a real-life case study in a pet retailer company. In particular, the standardized assessment of the O2C and P2P processes identified relevant optimization points for the demand forecasting model and adjustments in the supplier contracts.

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2 Approach

We introduce an Object-Centric Data Model (OCDM) and propose process mining techniques to exploit the OCDM.

1. **Introducing an Object-Centric Data Model (OCDM) for inventory management:** This paper develops an OCDM to simplify the complexity of data in O2C and P2P processes. The model unifies data from various systems including demand forecasting, ERP, and document metadata acquisition. It simplifies data structure while enabling the computation of relevant metrics and KPIs used in inventory management literature. We then extract a (single) object-centric event log (OCEL A).
2. **Introducing process mining techniques exploiting the OCDM:** Using the OCDM, the paper introduces process mining techniques to analyze inventory management by enriching the activities from OCEL A with existing inventory-related metrics (Economic Order Quantity, Reorder Point, Safety Stock, Maximum Stock, Overstock), obtaining OCEL B, which allows to assess the behavior of the process to improve efficiency and effectiveness.

3 Case Study

We conducted a case study with the European pet retail industry leader, confronting inventory management challenges in the seven-digit range. We applied our approach to real-life O2C and P2P processes utilizing the Logomate system for demand forecasting and replenishment, and SAP system for procurement and sales. We identified process behavior leading to understock and overstock situations. We then quantified the frequency of these behaviors and conducted a root cause analysis, enabling the definition of optimization measures for the demand forecasting model and adjustments in the supplier contracts. For example, we identified that the company orders materials, that are already in overstock, increasing stock levels unnecessarily. This behavior occurred several hundred times per year. Reasons for this behavior include the contractual agreements with suppliers about minimum order quantities. Our approach is reproducible and generalizable with any object-centric event log following the proposed OCDM.

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